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ECOLOGY OF NATIVE VERTEBRATES OF EVERGLADES NATIONAL PARK

A Research Proposal Submitted to the

National Geographic Society

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UNITED STATES
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NATIONAL PARK SERVICE
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VERTEBRATES OF EVERGLADES NATIONAL PARK

Introduction . . .

A variety of environments -- pinelands, hardwood hammocks, sawgrass everglades, cypress swamps, mangrove jungles, wet coastal prairies, brackish estuaries and the saline, shallow waters of Florida -- and the assortment of associated plant and animal life each combine to make Everglades National Park biologically unique and scientifically significant.

It is an area which experiences seasonal rainfall of 50 to 60 inches. Normally the dry season extends from November to April and the wet period is from May to October. Over 50 percent of the rain falls during the months of June, July, August and September. However, the extremes of very wet or very dry years are not common.

In addition to rainfall, fresh waters historically flowed into the Everglades as a slow broad sheet of water from the headwaters of the Kissimmee River in the Ocala area of north central Florida. Passing through the park these flows finally discharge into the Gulf of Mexico on the west and into the highly saline Florida Bay on the south. However, over the past 50 years, these natural flows have been altered, intercepted and diverted by drainage ditches and canals for flood control and land reclamation. Such disruptions of the natural flows, as well as to the periodic extremes in wet and drought conditions, hurricanes and fires, create situations which affect the food and habitat of the native faunal forms of the Everglades National Park.

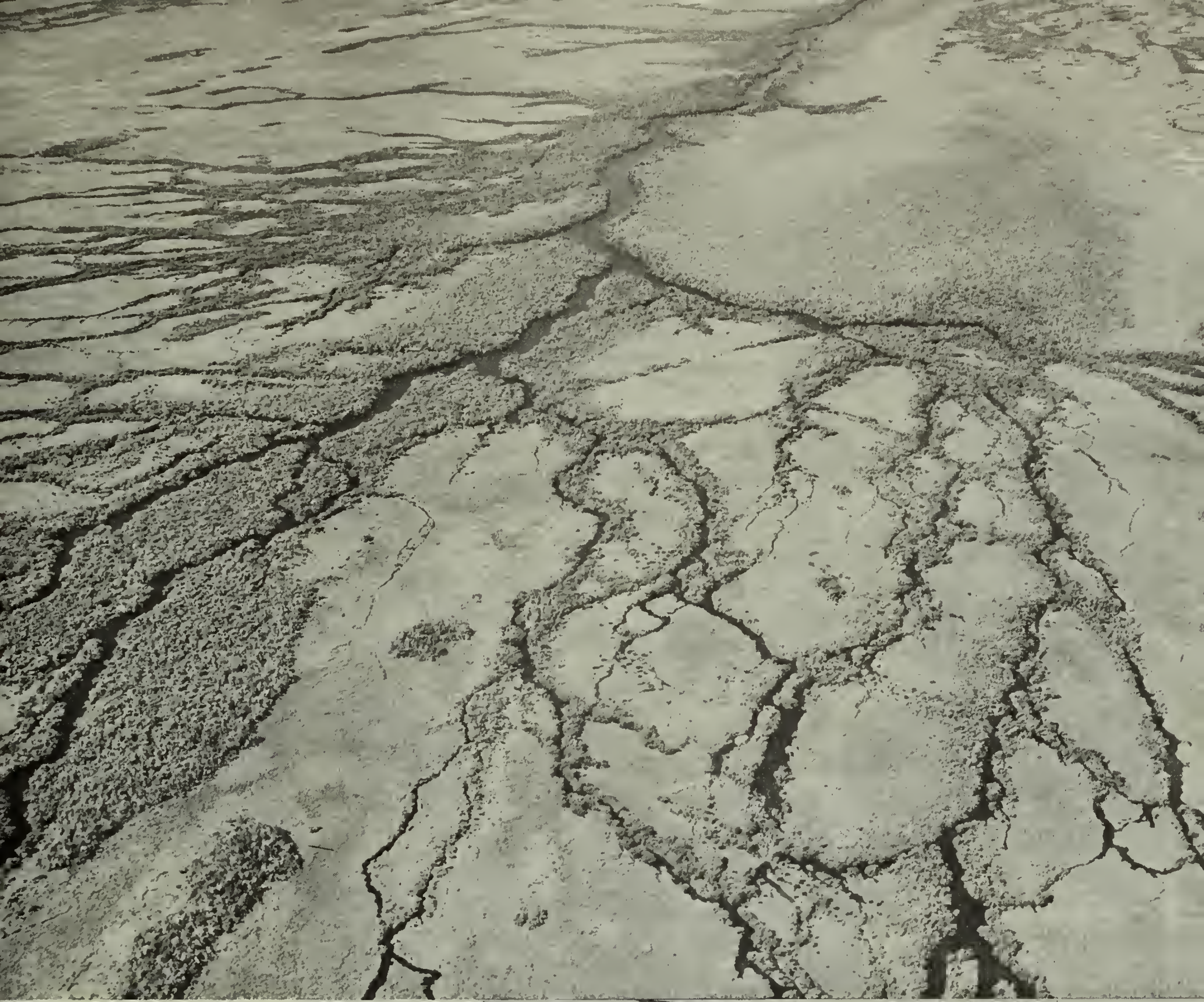
Too little is known of the life history, and the food and habitat requirements of many animal forms, especially the wading birds and certain mammals and reptiles found in the peculiar environmental habitats of the park.

Sea of sawgrass everglades spreads for miles and frequently engulfs the elevated hardwood hammocks.

A Variety of Environments for Everglades Animals are created by an Intricate Assortment of Vegetative Types.

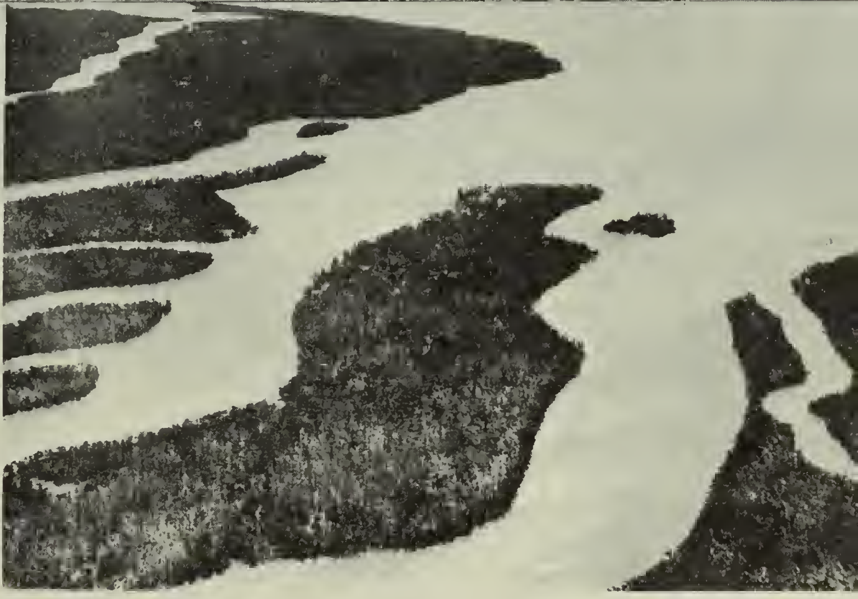
Pattern of mangroves near Florida Bay.

Mangroves elevated above the water on stilt-like roots.

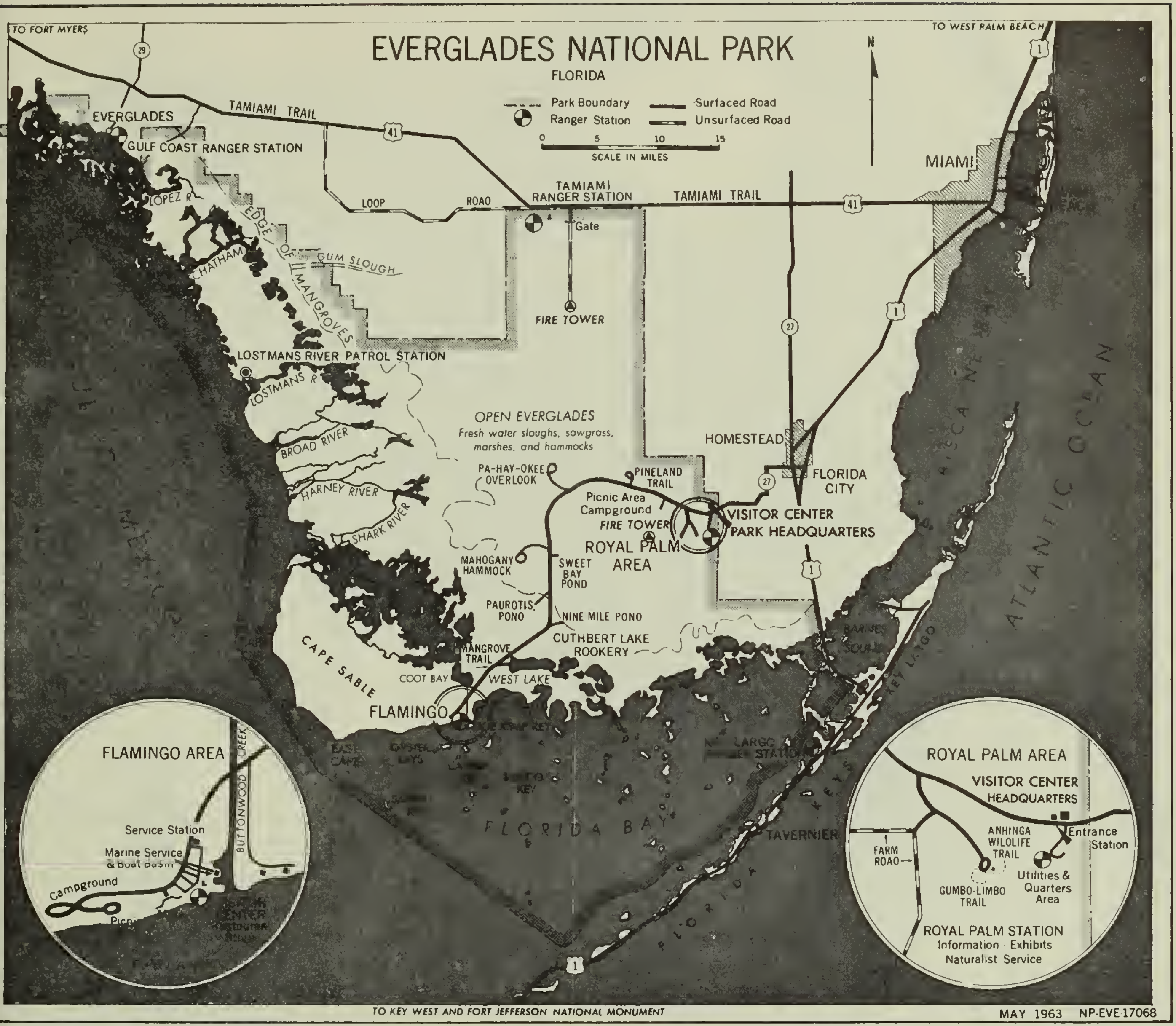


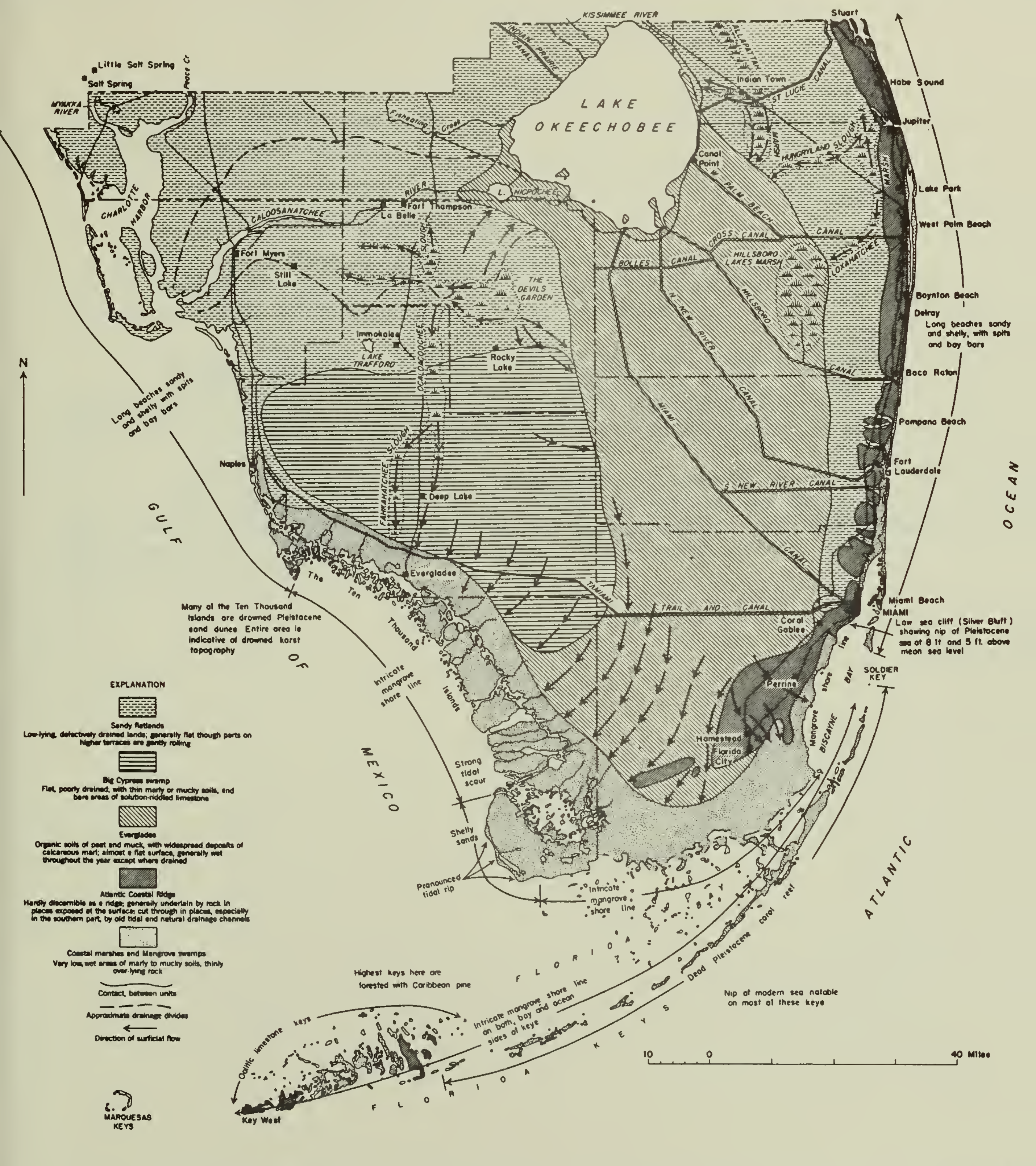
Headwaters of Shark River looking toward the southwest.

Fresh Waters Flow into the Park from the North and Drain to the Gulf of Mexico on the West and Florida Bay on the South.



Shark River enters the Gulf of Mexico through thickets of mangrove.


EVERGLADES NATIONAL PARK
FLORIDA
Park Boundary
Ranger Station
Surfaced Road
Unsurfaced Road
0
5
10
15
SCALE IN MILES
N
TO FORT MYERS
TO WEST PALM BEACH
29
41
1
27
EVERGLADES
GULF COAST RANGER STATION
TAMIAMI TRAIL
LOOP
ROAO
TAMIAMI
RANGER STATION
Gate
FIRE TOWER
MIAMI
LOPEZ R
CHATHAM
EDGE OF MANGROVES
GUM SLOUGH
LOSTMANS RIVER PATROL STATION
LOSTMANS R
BROAD RIVER
HARNEY RIVER
SHARK RIVER
OPEN EVERGLADES
Fresh water sloughs, sawgrass, marshes, and hammocks
PA-HAY-OKEE OVERLOOK
PINELAND TRAIL
Picnic Area
Campground
FIRE TOWER
ROYAL PALM AREA
VISITOR CENTER
PARK HEADQUARTERS
HOMESTEAD
FLORIDA CITY
MAHOGANY HAMMOCK
SWEET BAY POND
PAUROTIS PONO
NINE MILE PONO
CUTHBERT LAKE ROOKERY
MANGROVE TRAIL
COOT BAY
WEST LAKE
CAPE SABLE
FLAMINGO
BARNES SOUND
KEY LARGO
LARGO STATION
TAVERNIER
FLORIDA BAY
FLORIDA KEYS
BISCAYNE BAY
ATLANTIC OCEAN
FLAMINGO AREA
BUTTONWOOD CREEK
Service Station
Marine Service & Boat Basin
Campground
Picn
ROYAL PALM AREA
VISITOR CENTER
HEADQUARTERS
Entrance Station
ANHINGA WILDLIFE TRAIL
FARM ROAO
GUMBO-LIMBO TRAIL
Utilities & Quarters Area
ROYAL PALM STATION
Information · Exhibits
Naturalist Service
TO KEY WEST AND FORT JEFFERSON NATIONAL MONUMENT
MAY 1963
NP-EVE-17068


KISSIMMEE RIVER
Stuart
INDIAN PRAIRIE CANAL
Little Salt Spring
Salt Spring
Peace Cr
MYAKKA RIVER
LAKE OKEECHOBEE
ALLAPATTAH
Indian Town
ST LUCIE CANAL
Hobe Sound
Jupiter
Fisheating Creek
Canal Point
HUNGRYLAND SLOUGH
MARSH
Lake Park
CHARLOTTE HARBOR
L. HICPOCHEE
RIVER
Fort Thompson
CALOOSAHATCHEE
La Belle
PALM BEACH CANAL
West Palm Beach
Fort Myers
Still Lake
BOLLES CANAL
CROSS CANAL
HILLSBORO LAKES MARSH
LOXAHATCHEE
THE DEVILS GARDEN
N. NEW RIVER CANAL
HILLSBORO CANAL
Boynton Beach
Delray
Long beaches sandy and shelly, with spits and bay bars
Immokalee
OCALOACOOCHEE SLOUGH
LAKE TRAFFORD
Rocky Lake
MIAMI CANAL
Boca Raton
N
Long beaches sandy and shelly with spits and bay bars
Pompano Beach
FAKAHATCHEE SLOUGH
Naples
Deep Lake
Fort Lauderdale
S. NEW RIVER CANAL
OCEAN
GULF OF MEXICO
Everglades
TAMIAMI TRAIL AND CANAL
The Ten Thousand Islands
Miami Beach
MIAMI
Many of the Ten Thousand Islands are drowned Pleistocene sand dunes. Entire area is indicative of drowned karst topography
Coral Gables
Low sea cliff (Silver Bluff) showing nip of Pleistocene sea at 8 ft and 5 ft. above mean sea level
Intricate mangrove shore line
SOLDIER KEY
Perrine
Mangrove shore line
BISCAYNE BAY
Homestead
Florida City
Strong tidal scour
Shelly sands
Pronounced tidal rip
Intricate mangrove shore line
ATLANTIC
FLORIDA BAY
Dead Pleistocene coral reef
Highest keys here are forested with Caribbean pine
Intricate mangrove shore line on both, bay and ocean sides of keys
Nip of modern sea notable on most of these keys
Oolitic limestone keys
FLORIDA KEYS
10 0 40 Miles
MARQUESAS KEYS
Key West
EXPLANATION
Sandy flatlands
Low-lying, defectively drained lands; generally flat though parts on higher terraces are gently rolling
Big Cypress swamp
Flat, poorly drained, with thin marly or mucky soils, and bare areas of solution-riddled limestone
Everglades
Organic soils of peat and muck, with widespread deposits of calcareous marl; almost a flat surface, generally wet throughout the year except where drained
Atlantic Coastal Ridge
Hardly discernible as a ridge; generally underlain by rock in places exposed at the surface; cut through in places, especially in the southern part, by old tidal and natural drainage channels
Coastal marshes and Mangrove swamps
Very low, wet areas of marly to mucky soils, thinly over-lying rock
Contact, between units
Approximate drainage divides
Direction of surficial flow

TOPOGRAPHIC-ECOLOGIC MAP OF SOUTHERN FLORIDA

Mapping by Gerald G. Par

346881 O - 55 (In pocket) No.

Everglades National Park provides an excellent locale for such investigations for various reasons:

1. A variety of habitats exists within the park. Each is separate but distinctly related to each other.

2. The entire area is under protective management with a minimum amount of human interferences and activities to disturb the natural conditions of the habitats as they now exist.

3. Everglades National Park experiences periodic periods of flooding and drought which introduce conditions of stress in the life cycles of animals. It appears that the development of specialized adaptations in certain of these animals has facilitated their survival.

4. Major known nesting and breeding areas for some of the bird species are located within the park. Certain of the other major animal forms, such as the manatee and the crocodile, are relatively scarce and the park areas constitute an important amount of the remaining range in North America.

THE PROPOSAL...

A series of interrelated studies oriented toward improving our knowledge of the life history of certain important vertebrates of Everglades National Park is proposed. Particular emphasis is to be placed upon analysis of their interactions with the special environmental factors present in the park habitats.

The proposed program of investigations consists of two phases. One phase is expected to be concerned with the natural history of selected vertebrate forms. Various wading birds, mammals and reptiles associated with the Everglades are to be studied in detail. The second should concentrate on establishing the response of such animals to drought and other conditions which create environmental stress.

A literature survey has been compiled by Durbin C. Tabb. A copy of his report, "A Summary of Existing Information on the Fresh-water, Brackish-water and Marine Ecology of the Florida Everglades Region in Relation to Fresh-water Needs of Everglades National Park," accompanies this proposal. This report was compiled by The Marine Laboratory, Institute of Marine Science, University of Miami, under contract with the National Park Service. Reference is made here to it rather than repeat this information.

Discussions relative to Phase One are found on pages 38-55 and those concerned with Phase Two are included on pages 56-65. The survey does not presume to encompass all of the world literature pertaining to the ecology of some of these animals and to certain stress factors influencing their well-being. It does, however, suggest how much information on the life cycles and ecological requirements of these animals remains unknown.

The research activities proposed are outlined and discussed here in rather general terms only. It is expected, of course, that each investigator selected to participate will draw upon his specialized experience in the application of scientific methods and techniques known to be the most suitable means of achieving the desired objectives. Exact procedures and distribution of costs will be established later when the investigators have an opportunity to examine their assigned studies. When funds are assured the Service will contact prospective participants and secure detailed plans before the work starts.

Coordination of the research proposed will be the responsibility of the Park Superintendent, Stanley Joseph. Mr. Joseph has many years of experience in responsible administrative positions in the National Park Service. Members of his staff who will be most closely identified with the studies are: C. Burroughs, Assistant Superintendent, an archeologist by training; and Dr. William Robertson, Park Biologist, and several park naturalists with academic training and experience in biology.

Dr. Robertson secured his advance degree from the University of Illinois in 1955. His thesis, "An Analysis of the Breeding-Bird Populations of Tropical Florida in Relation to the Vegetation," deals with problems concerned with the Everglades. The following is a listing of some of his publications:

Robertson, William B., Jr.

1964. The terns of the Dry Tortugas. Bull. Fla. State Mus., Biol. Sci. 8: 1(May). 94 pp.

1963. Everglades - the Park story. Univ. Miami Press, Coral Gables, Fla. 95 pp. (Orig. print. July 1959)

1962. Florida region. Audubon Field Notes. 16: 5(Oct.), pp. 468-473.

1962. Ornithology of "The Cruise of the Bonton." Journ. Hist. Assoc. So. Fla. No. 22. pp. 65-77.

1962. Observations on the birds of St. John, Virgin Islands. The Auk. 79: 1(Jan.). pp. 44-76.

1961. A tern new to the United States. The Auk. 78: 3(July). pp. 423-425.

1959. Barred owl nesting on the ground. The Auk. 76: 2(April). pp. 227-230.

1955. An analysis of the breeding-bird populations of tropical Florida in relation to the vegetation. Ph.D. Thesis, University of Illinois. 613 pp. (Abstract: 1955. Dissertation Abstracts. 15: 5. 3 pp.)

1954. Everglades fires - past, present and future. Everglades Natural History. 2: 1(March). pp. 9-16.

and Hugh Bell Muller.

1961. Wild winds and wildlife; How Hurricane Donna killed 10,000 herons, egrets, ibis and spoonbills. Audubon M. Nov-Dec. pp. 308-311.

and Dennis R. Paulson.

1961. Florida Region (Effects of Hurricane Donna on Bird Life). Audubon Field Notes. 15: 1(Feb.). pp. 3-12.

and Edwin L. Tyson.

1950. Herpetological notes from eastern North Carolina. Journ. Elisha Mitchell Sci. Soc. 66: 2(Dec.). pp. 130-147.

The Challenge of Survival. A heron mirrored in a pool awaits a hapless fish.

Phase One . . .

Food and Habitat Requirements of Representative Vertebrates

Birds:

Wading birds are among the more showy and spectacular biological features of Everglades National Park. Concerted conservation efforts provided for their survival, in spite of earlier inroads made upon their numbers by ruthless plume hunters and exploitation. Survival of such birds as the great white heron, reddish egret, American Egret, snowy egret and roseate spoonbill in the park provides superb opportunities for studies of their natural history and the ecological requirements for their continued existence. Present understanding of the detailed features of their life history is in most instances remarkably sparse.

The kinds and amounts of foods utilized and required by various species are suspected to be different and are dependent upon availability, the birds' stages of development and on whether they are subsisting on a day-by-day basis or are rearing young. Some depend upon fresh-water food animals while others feed in tidal and brackish-water environments. The relationship between the character of various types of feeding areas and the volumes and types of food consumed at different stages in the life history needs to be determined as does the role played by availability and preference in establishing the composition of their diet.

Although the selected investigator will develop more specific field plans, the studies are expected to include intensive census of adult birds during the breeding and nonbreeding seasons to ascertain the numbers of birds supported by the rookeries areas and by the feeding areas. The breeding and feeding areas will be delineated and the factors which govern their selection and extent will be determined. In addition, it is hoped that studies can be made of the relationship between the quantity and quality of available foods and the stimulation of the development of rookeries. Movement of birds, both seasonal migrations and daily movements of parent birds engaged in feeding for the young, within as well as outside the park, are to be established through a capture and banding and marking program and by observation from low-flying aircraft.

Feeding and nesting behavior of wild birds will be observed from a distance with binoculars or telescope and at close range visually and photographically from blinds erected at the principal feeding grounds. Qualitative samples of the food organisms are to be collected by use of dip nets and seines, while quantitative samples of the food organisms will be made with a one square meter drop trap to determine their density. Organisms will be identified in bird stomach contents taken at various seasons of the year. A series of "laboratory" experiments with captive birds will be conducted to determine the food preference of the birds and the volumes of food consumed.

The extent of the dependence of individual species of birds upon food organisms produced in fresh water, brackish water, or in salt water will be investigated. The rookeries of certain of the birds are now more often located in areas of greater fresh-water abundance outside the park. It is likely, therefore, that studies of food utilization and abundance, as well as of habitat conditions, will be undertaken periodically during the year in the present feeding and rookery sites and in locations formerly occupied by the birds within the park boundaries.

Rookery formation depends upon many ecological factors which need to be determined by scientific endeavors. (Cuthbert Lake rookery and mangroves near Florida Bay.)

Information on rookery formation and nesting activities will be secured from low-flying aircraft and from observation platforms erected at the breeding sites.

Hydrological data will be correlated with the ecological data to analyze the relationship between the water levels, the availability and utilization of food and the development of breeding condition.

Investigations by M. Philip Kahl on the wood stork in the Big Cypress Swamp region of western Florida, just north of the park boundary, revealed a strong reliance of nesting birds upon the food fishes produced during the preceding season of high water. The parent birds are "grope feeders," and evidently need to find fishes in such great quantity during the nesting season that they literally stand in "fish soup." Under these conditions their catches allow quick gorging and return to the young. The

Big Cypress wood stork study established estimates of the tonnage of food required by a rookery of adults and young birds and made an evaluation of the ecological conditions necessary to meet this demand for food. Conditions required for successful rookery formation and nesting survival were also determined. Mr. Kahl's most recent report on this study, entitled "Food Ecology of the Wood Stork (*Mycteria americana*) in Florida," appears in the spring 1964 issue of *Ecological Monographs*.

Similar information is to be sought for other major wading birds. The reddish egret, for example, survives in the eastern United States only in southern Florida and there chiefly in the Florida Bay section of the park. Prior to the plume hunting of the late 1800's, the reddish egret was abundant in Florida but decreased in numbers to the threshold of extinction. Despite effective protection afforded the remnant flocks, only limited response is evident since the 1935 hurricane. Present population numbers fewer than 300 individuals. Little detailed biological information on the species exists. It is expected that detailed investigations will be undertaken to determine present status and life history in an effort to identify major factors which limit this bird's increase in numbers.

'GATOR HOLE. At low spots in the Everglades, alligators dig holes where many forms of animal life survive during dry periods. From these retreats, the glades are repopulated when summer rains come and water levels rise. Studies are designed to learn more about ecological relationships between faunal forms and about survival during dry periods and times of drought.

Phase One . . .

Food and Habitat Requirements of Representative Vertebrates

Other Vertebrates:

The unusual habitats found within Everglades National Park are occupied, as well, by other major animal forms of substantial interest to biologists and park visitors alike. Although life history studies have been undertaken on some, most of the species have received remarkably little concerted attention. Food and habitat requirements, abundance, distribution, and the relationship of fresh-water supplies of the relatively unusual forms, such as the alligator, river otter, crocodile and manatee, are quite poorly known.

The activities of alligators evidently play an important role in the survival of certain other animals during dry periods. Big alligators frequently dig ponds at low places in the glades and return to these private retreats each dry season, deepening and enlarging the pond as the years pass. Such ponds, known as "'gator holes," provide places where marsh snails, frogs, and fish can readily survive the dry months to aid in repopulating the glades when summer rains come and the water level rises again. The full significance of the alligators in this role is incompletely understood.

Much less is known about the life history and habits of the crocodile than of the alligator. Once more widely distributed, the crocodile's range in the United States is now restricted to a limited area in southern Florida. Their numbers have diminished through hunting, real estate developments and other activities of man until today they are seldom seen outside of Florida Bay and a few places in the Florida Keys. Thus the park provides a vital sanctuary for these creatures. The limited information available about the species in the United States has been summarized by Moore (1953: The Crocodile in the Everglades National Park, Copeia, 54-59). In recent years the impression has grown that the crocodile population in the park may be declining despite protection. Crocodiles, however, are not easily observed and reliable reports are few; only concerted field research will provide factual information on the present status and requirements of this species and furnish the fundamental data necessary to the development of adequate measures for protecting and maintaining these interesting animals.

The manatee, another scarce faunal form in North America, has been subjected to little intensive research effort aimed at establishing its true requirements for survival. The rivers, within the park, flowing into Whitewater Bay along the gulf coast constitute a significant portion of the remaining range of this species in the United States. A sound and thorough investigation of the manatee, its natural history, limits of tolerance of habitat conditions, range, movement, food requirements, etc., would supply information much needed for our preservation of this unusual animal.

Some of the more common animals in the park have received intensive study in other regions, but their roles in the park ecosystem have not been carefully investigated. Thus, hundreds of ecological problems and those of population interaction await the attention of competent investigators. There is substantial doubt that even the faunal lists of park animals, particularly those regarding the amphibians, reptiles and invertebrates, are anywhere near complete. It would seem that almost any well-planned and executed study of nearly any animals in this remarkable habitat would contribute significantly to our understanding of such wild creatures in their natural and unspoiled habitats.

Phase Two . . .

Response of Everglades Fauna to Drought

Animals which live in a region having marked wet and dry seasons often have physiological, behavioral or morphological adaptations which permit survival of at least a nucleus of the population during periods of severe drought. Observations made in Everglades National Park suggest that many aquatic and semiaquatic animals may survive drought by burrowing in wet peat soils, by following the receding water table below the ground surface via crayfish burrows, or by entering the water table through natural solution channels in the porous Miami oolite limestone.

There are variations in the efficiency of survival adaptation; the most successful animals are those that can find sufficient moisture or reduce their moisture requirements for the longest time by whatever means. Some animals are unable to do more than burrow weakly into soft soils (i.e., the apple snail, Pomacea depressa) while others, like the crayfish, Procambarus allenii, are able to excavate passages and thus follow the receding water. The relative importance or effectiveness of these adaptations as they relate to soil type, rock porosity, and soil moisture content are not well understood.

Other animals simply leave their normally occupied areas as the effects of drought increase and take up a precarious existence in crowded areas of refuge where adequate moisture is present. No one knows the actual long-range influences upon population structure of such stressful conditions. Still other animals enter a state of aestivation until adequate ambient moisture is reestablished. Many questions concerning aestivation remain unanswered at this time.

Intricate investigations of the physiological and morphological mechanisms for response to the stress of drought are ultimately desirable. In the case of Everglades animals, however, so little factual information is available on drought reactions that it seems necessary to limit initial investigations to those concerned with gross behavioral and physiological responses to such conditions of stress. Once these have been established, the studies can be expanded to include more sophisticated analyses of the mechanisms which stimulate and sustain the response and the physiological reactions of the organisms.

This work is to be conducted in areas most affected by falling water tables during dry seasons, and where sufficient animal life normally exists in order to make the studies most productive. There are many such bodies of water in the Everglades National Park, typified by Taylor Slough and the higher lands bordering the Shark River Valley.

These studies will probably be oriented initially to the fresh-water portions of the park; later the saline marshes and estuaries of the coastal plain are to be included. Thus, the initial test sites will be established in shallow ponds of the higher rockland portions of the park where surface waters normally recede below the surface during dry seasons.

Quantitative studies of selected animal populations will be conducted at the sites during high water periods and continued as the surface water recedes below the adjacent ground surface and finally, the bottom of the pond. Careful observation is to be made of depth of penetration into the bottom soil by the residual pond inhabitants, as well as of the rate and distance of movement out of the pond by appropriate animals such as frogs, alligators, salamanders, and turtles. Portions of the ponds will be excavated carefully to show depth of penetration and the numbers and kinds of animals involved, their condition of well-being, moisture, chemical and gaseous content of the subsurface environment, and the duration of time which the animals can survive under such conditions.

Careful measurements should be made of water-table levels in the vicinity and of water quality in the subterranean environments of burrows, cavities, etc. Some animals may modify their environment by the addition of carbon dioxide, and thus create favorable conditions in such sites for survival by lowering their metabolic rate. Other animals may require highly oxygenized water. Thus, the oxygen and carbon dioxide content of water in burrows and in natural solution holes should be monitored and the identity and general physical conditions of the occupying animals established.

Certain of the test sites will be carefully fenced with small-mesh wire in order that estimates may be made of drought survival by proper sampling of animals that appear within the enclosure as the rainy season progresses and the water level rises. Some estimate of rate of recolonization of surrounding areas can also be made at trapped openings in the fence.

While the field aspects of the study are underway, studies should be carried out in the laboratory on the ability of animals to withstand dessication, their tolerance to high carbon dioxide concentrations, and their burrowing ability under differing conditions of soil moisture and soil density.

The kinds of animals to receive the most attention in this phase of the overall investigation will be dependent upon the personal interests and research experience of the senior investigator involved.

Personnel . . .

We intend that the principal investigators associated with this program will be scientists of high professional competence. Individuals listed below or those of equal caliber will be approached for possible supervision of the indicated phase of the research program. (The academic background of each is listed as it appears in the 1960 edition of the American Men of Science.) As previously stated, none of these individuals have been contacted relative to their participation as yet.

Phase 1: Food and Habitat Requirements of Representative Vertebrates of Everglades

Birds:

FRIEDMANN, DR. HERBERT, Smithsonian Institution, Washington 25, D. C. VERTEBRATE ZOOLOGY, ORNITHOLOGY. New York, N.Y., April 22, 00; m. 37; c. 1. B.S, City Col, 20; Ph.D.(ornith), Cornell, 23. Asst. ornith, Am. Mus. Natural Hist, 20; instr. zool, Cornell, 22-23; Nat. Res. Council fel, Bussey Inst, Harvard, 23-26; instr, Brown, 26-27; instr. biol, Amherst Col, 27-29; CURATOR DIV. BIRDS, U.S. NATURAL MUS, 29-57, HEAD CURATOR ZOOL, 57- Expeds, Mex. border, Argentina, south, east & cent. Africa. Del, Int. Ornith. Cong, Oxford, 34; Upsala, 50. Elliot medal, Nat. Acad. Scis, 59. U.S.A, 18-19. A.A; Soc. Nat; Soc. Zool; Cooper Ornith. Club; fel. Ornith. Union (v.pres, 32-38; pres, 38-39). Systematic ornithology; brood parasitism; natural history symbolism in medieval and Renaissance art; animal behavior; physiological cycles and cyclical instincts; theoretical biology.

AMADON, DEAN, American Museum of Natural History, New York 24, N.Y. ORNITHOLOGY. Milwaukee, Wis, June 5,12; m. 40; c. 2. B.S, Hobart Col, 34; Ph.D, Cornell, 49. Wildlife technician, State Bd. Fish & Game, Conn, 36-37; LAMONT. CURATOR BIRDS, AM. MUSEUM NAT. HIST, 37- Lectr, Wisconsin, 54. A.A; Soc. Nat; Ornith. Union; Wilson Ornith. Club; Cooper Ornith. Soc; Soc. Study Evolution; Soc. Mammal. Avian taxonomy; evolution of birds.

DRURY, DR. WILLIAM H(OLLAND), JR, Drumlin Farm, South Lincoln, Mass. ECOLOGY. Newport, R.I, March 18, 21; m. 51; c. 3. B.A, Harvard, 42, M.A, 48, fel, 49-52, Ph.D, 52. Asst. prof. biol. & ed, Harvard, 52-56; DIR. ED. & DRUMLIN FARM, MASS. AUDUBON SOC, 56- U.S.N, 42-46. Ecol. Soc; Ornith. Union; Wilson Ornith. Soc; Arctic Inst. Ecol. Soc, British. Bird ecology and behavior; plant ecology relative to geological process.

LOWERY, DR. GEORGE H(INES), JR, Museum of Natural Science, Louisiana State University, Baton Rouge 3, La. ORNITHOLOGY. Monroe, La, Oct. 2, 13; m. 37; c. 2. B.S, La. State, 34, M.S, 36; Ph.D, Kansas, 49. Instr. ZOOL, LA. STATE, 36-39, asst. prof, 38-46, assoc. prof, 46-53, prof, 53-55, BOYD PROF, 55-, DIR. MUS. NATURAL SCI, 52-, mus. zool, 36-58. Cooper Ornith. Soc; Wilson Ornith. Soc; Ornith. Union. Taxonomy, classification and distribution of birds and mammals; bird migration.

Other Vertebrate Animals:

HAMILTON, DR. WILLIAM J(OHN), JR,* (Cornell Univ.) ZOOLOGY. Corona, N.Y, Dec. 11, 02; m. 27; c. 3. B.S, Cornell, 26, M.S, 28, Ph.D.(zool), 30. Asst. biol, CORNELL, 26-30, instr. ZOOL, 30-36, asst. prof, 37-41, assoc. prof, 41-47, PROF, 47- Res. assoc, mammal, Am. Mus. Natural Hist. Chmn. sci. adv. cmt, Edward Niles Huyck Biol. Sta, 39-; mem. environmental biol. panel, Nat. Sci. Found, 56-58. Sanit.C, 42-46, Maj. A.A; Soc. Nat; Soc. Zool; Soc. Syst. Zool; Soc. Mammal.(v.pres, 49-50, pres, 50-51); Ecol. Soc.(secy, 39-41, pres, 55); Wildlife Soc; Soc. Ichthyol. & Herp; Wilson Ornith. Soc; Ornith. Union; fel. N.Y. Acad. Ecology and life histories of North American mammals; vertebrate ecology; mammalian life histories and morphology; ornithology; herpetology; food habits of American vertebrates.

*Note: Recently retired but actively engaged in summer research at Ithaca. Spends winters in Florida.

COWLES, DR. R(AYMOND) B(RIDGMAN),* Dept. of Zoology, Univ. of California at Los Angeles, Los Angeles 24, Calif. BIOLOGY. Amanzimtoti, Natal, S. Africa, Dec. 1, 96; m. 28; c. 2. A.B, Pomona Col, 21; Ph.D.(vert. zool), Cornell, 28. Asst. biol, Cornell, 21-23, instr, 23-25; Cornell, 22-25; biol. invests, S. and E. Africa, 25-27; assoc, CALIFORNIA AT LOS ANGELES, 27-29, instr, 29-30, asst. prof, 30-39, assoc. prof, 40-47, PROF. ZOOL, 47- Advisory board, Palm Springs Desert Museum; cor. mem, Am. Mus. Nat. Hist. U.S.N.R, 17-19. A.A; Soc. Ichthyol. & Herp; assoc. Soc. Study Evolution; assoc. Cooper Ornith. Club(secy, 35; v.pres, pres, 36; governor); fel. Herpetol. League. Soc. Nat; West. Soc. Nat. Herpetology; mammalogy; ornithology; ecological effects of high temperatures and heat induced sterility; climate and evolution; human ecology.

*Note: Retired a year ago but still active. Completed a study on aquatic reptiles in Africa approximately two years ago.

BUECHNER, DR. HELMUT KARL, Dept. of Zoology, Washington State University, Pullman, Wash. WILDLIFE MANAGEMENT. Scotia, N.Y, Aug. 5, 18; m. 42; c. 2. B.S, Syracuse, 41; M.S, Agr. & Mech. Col. Texas, 43, 45-48; Ph.D.(zool), Okla. State, 49. Instr. WILDLIFE MANAGEMENT, Agr. & Mech. Col. Texas, 47-48; STATE COL. WASH, 48-51, asst. prof, 51-56, ASSOC. PROF, 56- Fulbright fel, Uganda, 56-58. A.A.F, 43-45, pilot. A.A; Ecol. Soc. (Mercer award, 51); Soc. Mammal; Wildlife Soc; Soc. Range Mgt; Northwest Sci. Asn. Wilderness Soc. Population dynamics and ecology of terrestrial vertebrates, particularly big game mammals.

VAN DEUSEN, HOBART M(ERRITT), American Museum of Natural History, Central Park W. at 79th St, New York 24, N.Y. MAMMALOGY, ORNITHOLOGY. Newark, N.J., Nov. 20, 10; m. 35; c. 1. A.B, Dartmouth Col, 33. Specialist, AM. MUS. NATURAL HIST, 45-58, ASST. CURATOR, ARCHBOLD COLLECTIONS & EXPEDS, 58- Mammalogist, Archbold Cape York Exped, Australia, 48; Archbold Exped, New Guinea, 53, Vose Explor. Fund grant to exped, 59. A.A; Soc. Study Evolution; Soc. Syst. Zool; Soc. Mammal; Australian Mammal. Soc. Taxonomy, distribution, ecology and life history studies of mammals of New Guinea, tropical Australia, Indonesia and Western Oceania; preservation of natural areas in eastern North America; breeding bird studies in eastern United States.

Phase 2: Response of Everglades Fauna to Drought

HEATWOLE, DR. HAROLD F(RANKLIN), Dept. of Biology, University of Puerto Rico, Rio Piedras, P.R. ZOOLOGY. Waynesboro, Va, Dec. 2, 34; m. 55; c. 2. B.A, Goshen Col, 55; Nat. Sci. Found. fels, Michigan, 55-56, 57-59, Univ. fel, 56-57, M.S, 58, Ph.D.(zool), 59. Instr. zool, Michigan, 59-60; ASST. PROF. BIOL, PUERTO RICO, 60- Mycol. Soc; Soc. Ichthyol. & Herp; Ecol. Soc; Soc. Study Evolution. Interspecific competition; microhabitat selection; natural history and ecology of amphibians and reptiles.

BLAIR, DR. W(ILLIAM) FRANK(LIN), Dept. of Zoology, University of Texas, Austin 12, Texas. ZOOLOGY, ECOLOGY. Dayton, Texas, June 25, 12; m. 33. B.S, Tulsa, 34; M.S, Florida, 35; Ph.D. (zool), Michigan, 38. Asst, mammal div, museum zool, Michigan, 35-37, research assoc, lab. vert. biol, 37-46; asst. prof. ZOOL, TEXAS, 46-47, assoc. prof, 47-54, PROF, 55- res. scientist genetics found, 51-54; dir. res. vert. speciation, 53- U.S.A.A.F, 43-46. A.A; Soc. Nat; Soc. Mammal; Soc. Ichthyol. & Herp, (v. pres, 56); Genetics Soc; Ecol. Soc, (v. pres, 56); Soc. Study Evolution (treas, 55-57, v. pres, 58); Soc. Syst. Zool. Population genetics; ecology and speciation of mammals, reptiles and amphibians; mating call as an isolation mechanism in anurans; population dynamics of terrestrial vertebrates; biogeography of North America.

INGER, DR. ROBERT F(REDERICK), Chicago Natural History Museum, Chicago 37, Ill. HERPETOLOGY. St. Louis, Mo, Sept. 10, 20; m. 46. B.S, Chicago, 42, Ph.D, 54. Asst. reptiles, CHICAGO NATURAL HIST. MUS, 46-48, asst. curator fishes, 49-54, CURATOR OF REPTILES, 54- U.S.A, 42-45. Soc. Study Evolution; Soc. Ichthyol. & Herp. Taxonomy and population ecology of reptiles; taxonomy and ecology of Oriental and African amphibia.

BOGERT, DR. CHARLES M(ITCHILL), American Museum of Natural History, New York 24, N.Y. HERPETOLOGY. Mesa, Colo, June 4, 08; m. 37; c. 2. A.B, California at Los Angeles, 34, A.M, 36. Teaching asst. California, Los Angeles, 34-36; asst. curator dept. herpetol, AM. MUSEUM NAT. HIST, 36-41, asst. curator in charge, 41-42, assoc. curator IN CHARGE DEPT. AMPHIBIANS & REPTILES, 42-43, curator, 43-45, CHMN & CURATOR, 45-, secy, council of sci. staff, 46-48, dean sci. staff, 49-51, 56-57. Carnegie Corp. grant-in-aid, Mex, 39. Cor. mem. Senckberg Museum, 54- Guggenheim fel, 55-56. Lectr, California, 42, 45, 47; Mountain Lake Biol. Station, Virginia, 50; sci. investigator, 52. A.A; Soc. Nat; Soc. Ichthyol. & Herp. (v. pres, 41; pres, 52-54); Soc. Study Evolution (treas, 52-54, v. pres, 56); Soc. Vert. Paleont; Ecol. Soc; fel. N.Y. Acad; Soc. Hidrobiol. Mex; fel. Acad. Zool, India. Zoogeography of North America and Africa; thermal requirements of reptiles; behavior, distribution, taxonomy and morphology of reptiles and amphibians; ecology and evolution of reptiles.

Budget . . .

A general breakdown of the anticipated cost of starting the studies and carrying them through the first year is presented. Adjustments can be expected as definite plans are developed after an investigator has been selected. It is believed, however, that the proposed budget is a realistic measure of the overall requirements. The research is expected to be a continuing effort for a total period of 3 to 5 years. Park personnel will be able to advise on the conduct of the research and provide occasional equipment use. Park resources, unfortunately, cannot be anticipated to contribute more than is now being handled because of manpower shortages and Congressional limitations on research funds to be used for Everglades studies.

	Birds	Other Vertebrates	Drought Reactions	Total
Salaries				
Chief Investigator (Est. 3 mos. seasonal salary)	$ 5,000	$ 5,000	$ 5,000	$15,000
Graduate Assistants @ $4200/year	8,400	8,400	4,200	21,000
Hourly Help	1,500	1,500	1,500	4,500
				$40,500
Permanent Equipment				
Blinds	500			500
Observation Platforms	500			500
Fenced Enclosures			1,000	1,000
Sampling Devices,				
Collecting & Capture Gear	500	500	500	1,500
Photographic Equipment	500	500	250	1,250
				$ 4,750
Expendable Supplies				
Film & Developing				
Tags, preservatives, bottles, seines, nets, etc.	500	500	250	1,250
				$ 1,250
Transportation				
To and from Park	1,000	1,000	1,000	3,000
Per Diem (in research area)	3,000	3,000	1,500	7,500
Auto Mileage @7.5¢/mi. (in research area)	1,000	1,000	500	2,500
Airboat Rental (in research area)	500	500	250	1,250
Airplane Rental (in research area)	1,200	500	250	1,950
Motorboat Rental (in research area)	500	500	250	1,250
				$17,450
Totals	$24,600	$22,900	$16,450	$63,950

Current Research Activities in Everglades National Park . . .

The investigations proposed in this statement will complement research being conducted within Everglades National Park. A number of agencies, in addition to the National Park Service, are participating and contributing to this overall research effort. A listing of some of the major studies follows.

It can be anticipated that some of these cooperative studies will develop basic data and maps directly applicable to the studies proposed in this prospectus. The interchange of data and ideas among all who will be conducting studies concurrently on various phases of the ecology and water resources of this area should strengthen the work of all.

One can conceive, in fact, of the higher forms of animal life, the mammals and birds, as a reflection of the end effect of the interplay of the important ecological factors of the total environment -- a measure of the natural economy of the whole. Thus, the studies of the bird and animal life at the Everglades, related to the total environment through studies of reaction to water regimen, can be looked upon as the climax study that ties together and makes more meaningful the results of all of the other studies of the environmental factors of this interesting region.

A. Hydrological Investigations

1. Study of Fresh-water Sources. With an appropriation especially earmarked for this purpose, the Corps of Engineers has initiated an intensive study of the Central and Southern Florida Flood Control Project to determine the most feasible methods of providing the fresh water necessary to satisfy the ecological requirements of Everglades National Park. First Year: $68,000

2. Hydrological Studies, U. S. Geological Survey. Investigations are currently being conducted by the U. S. Geological Survey to determine and to evaluate the quality and quantity of remaining available surface and ground water supplies in Florida and in Everglades National Park. These studies include: (1) the systematic collection, analysis, and interpretation of water data in relation to the environment, and (2) research to improve the understanding of physical laws, processes and mechanics of various phases of the hydrologic cycle.

Within the park, specifically, the U.S.G.S. has established stations to record waterflow and stage, to measure rainfall and evaporation, and to determine the quality of surface water. It has drilled observation wells to record stages and to determine the quality of ground water. In sections of the park where salt-water encroachment has upset ecological balances the chloride content of the ground water is being determined. A deep test well will be drilled this year for the purpose of analyzing the quality and quantity of deep-well water as a possible supplementary source of supply to maintain some of the biota. An ecologist employed by the Survey is conducting investigations directed toward determining the limits of tolerance of the park biota to hydrologic changes and toward integrating the hydrological and ecological information into a comprehensive program, to the limited extent this can be done by one person. These phases of the investigations within the park are being financed by the National Park Service.

$62,000

Annually: $83,000

In addition, the U.S.G.S. is conducting investigations, financed by the U. S. Bureau of Sport Fisheries and Wildlife, to determine and to define variations in the salinity of the estuaries and rivers which critically affect the survival of the Everglades biota, and to correlate these variations in relation to the park's fresh-water flows and to bay tides.

Estimate per year: $15,000

Recently, the U. S. Geological Survey report entitled "Preliminary Evaluation of Hydrologic Situation in Everglades National Park, Florida," by J. H. Hartwell, H. Klein, and B. F. Joyner defined and analyzed flows into the park since 1939. This document constitutes an important contribution to the understanding of these rather recent waterflow patterns, and the significance of present water shortages.

B. Ecological Investigations

1. *Ecology of Fresh-water Environments*. As mentioned previously, an ecologist is investigating some fresh-water ecological conditions with the objective of correlating the ecological demands for fresh-water supplies with the hydrological data which has been secured and is being collected.

2. *Estuarine Ecological Investigations in Relation to Water Supplies*. A 3-year study of the ecology of the estuarine waters of Everglades National Park was initiated in September 1963 by The

Marine Laboratory, Institute of Marine Science, University of Miami, under a grant from the U. S. Public Health Service. The purpose of this study is to describe the biotic communities of two extensive estuarine areas of the park, to determine the water requirements of plant and animal life, and to relate modifications of these communities to changes in salinity and other hydrographic conditions. This study is being conducted by Dr. C. P. Idyll and Mr. Durbin Tabb.

Approximate per year: $75,000

The current investigations complement previous estuarine studies conducted in Whitewater Bay and adjacent estuaries by Mr. Tabb and his associates. These investigations were supported by the Florida State Board of Conservation.

C. Additional Investigations

1. Pink Shrimp Investigations. The pink shrimp constitutes a multimillion dollar fishery industry on the Tortugas and Sanibel grounds. Park estuarine waters are significant nursery grounds for the baby shrimp. Studies relating to the shrimp in these waters are being conducted by the Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service. Fresh water flowing through the park and into the estuaries and bays is essential to these natural shrimp nurseries.

Per year: $150,000

2. Dynamics of Florida Bay Fisheries. Fishes of Florida Bay provide the basis for important sport and commercial fisheries. The dynamics of the fish populations in relation to the catch is being studied in a program directed toward maintaining the catch within the natural productive limits of the resource. Florida Bay is a highly saline body of water which is maintained within tolerable salinity range by the dilution created by inflows of fresh water. These investigations, supported by the National Park Service, are being conducted on a very limited scale by The Marine Laboratory, University of Miami.

Per year: $7,000

3. Aerial Mapping and Photography. The water situation in Everglades involves extensive hydrologic and ecological studies which necessitate an accurate map of the park. costs of Usual mapping procedures would be prohibitive in this area. Semicontrolled photo-mosaics are needed to provide standard map accuracy. In addition, medium-altitude aerials

in color will be effective for stereo photo-interpretation of vegetation, water depth, land height, etc., for both hydrologic and ecological studies. Aerial photography, financed by the National Park Service, is being done by the U. S. Geological Survey. ?

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Per year: $10,000

D. Investigations Being Conducted by Park Biologist, Dr. William B. Robertson, Jr. (in addition to bird studies at Fort Jefferson National Monument) $6,900

1. Effects of Control Burning of Pinelands. Pinelands of Everglades National Park constitute a subclimax vegetative type perpetuated by fire. Research is being conducted to measure growth of pines and regrowth of hardwoods on Control Blocks burned previously.

2. Biological Effects of Hurricane Donna. This continuing study is being made to determine the biological effects of Hurricane Donna and the rate of recovery of park fauna and flora.

3. Bald Eagle Studies. This threatened national symbol receives continued study as to its population trends and distribution within the park.

4. Ardea Investigations. Limited investigations of the Great White and Great Blue Herons have been directed toward clarifying the seasonal distribution and breeding occurrences within the park through aerial census methods.

5. South Florida Birds. Recording, tabulation, and study of historic records and examination of specimens on the occurrence of birds in southern Florida is being accomplished in this continuing project. Technical accounts of the bird distribution of south Florida and a popular handbook on birds of the park are anticipated from this study.

Bibliography . . .

Durbin Tabb incorporated a comprehensive survey in his report, "A Summary of Existing Information on the Fresh-water, Brackish-water and Marine Ecology of the Florida Everglades Region in Relation to Fresh-water Needs of Everglades National Park." This publication accompanies this proposal. Reference is made to the listings contained in it rather than repeat this information. Additional references are cited below:

Kahl, M. Philip

1964. Food ecology of the wood stork (*Mycteria americana*) in Florida. *Ecological Monographs*. 34:2. pp. 97-117.

Moore, Joseph

1953. The crocodile in the Everglades National Park. *Copeia* No. 1. pp. 54-59.

Dr. George Sprugel, Jr.
O. L. Wallis
August 15, 1964